International SEMATECH Wafer Probe Council

"Vertical Probing Experiences"

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2003 Southwest Test Workshop

Outline

Probe Council Overview

What is ‘Vertical’ Probe Technology

Member Company Experiences

Key Challenges

Wrap-up

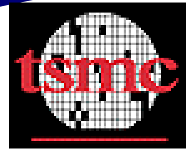
Probe Council Overview: Mission

- International SEMATECH Mission
  - The members of International SEMATECH cooperatively set global industry direction and accelerate technology solutions in infrastructure, lithography, materials, and manufacturing to ensure a strong and vibrant semiconductor industry.
- Probe Council Mission
  - Provide the means to improve member company technology in wafer probing technology & methods by sharing best practices, employing benchmarking techniques, observing member company operations and guiding the supplier community.

Probe Council Overview: Roles

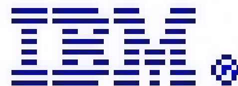
- Custom Funded Project
  - SEMATECH: Legal, Technical & Administrative Support
  - Members: Technical Data & Information, Know-how & Direction…..and Dues

Probe Council Overview: Members



PHILIPS

MOTOROLA



Vertical Probe Technology: Definition

- "Vertical probes…..deliver a tangential force at the top of solder pads….."
  - From ref. 1: Area Array Interconnect Handbook
- Alternatively:
  - Electrical path and mechanical structure is essentially vertical from the contact with the chip I/O to the interface with the Spacetransformer
- **Your Definition?**

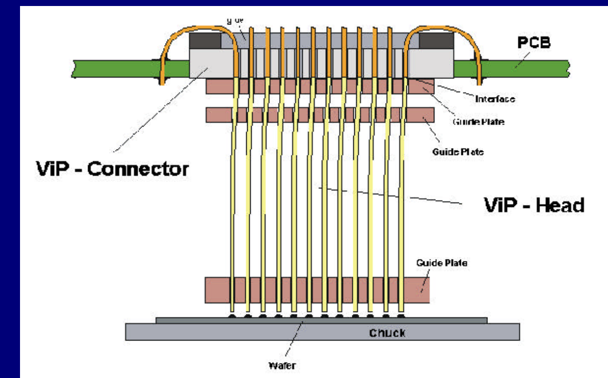
Experiences: Data Sources

- Member Company Topic Presentations
- Special Vertical Probe Survey for SWTW

		1	2	3
Probe Card	Type/Technology			
	Manufacturer			
	Product Name			
Application	Product Type			
	I/O Type			
Leadtime	1st			
	Subsequent	Enter Data	Enter Data	Enter Data
I/O Count	Minimum			
	Maximum			
I/O Layout	Pitch			
	Type			
Typ. Lifetime	# Touchdowns			
Cleaning	Frequency			
	Technique			
Repair	In-house			
	Supplier			
Selection	Why?			
	2nd Sourcing Required (Y/|N) / If Yes name Supplier			
Spacetransformer	Type			
	Sourcing			
Other	Strengths			
	Weaknesses			

Experiences: Probe Technologies

- Buckling Beam & Hybrid Buckling Beam
  - Wire Through Guide Plates
  - Sourced From
    - Feinmetall (ViProbe®)



Courtesy of Feinmetall

    - IBM (COBRA)
    - Int'l Contact Tech. (VCT)
    - K & S (CobraProbe™)
    - MicroProbe (Apollo™)
    - Wentworth Labs (COBRA®)

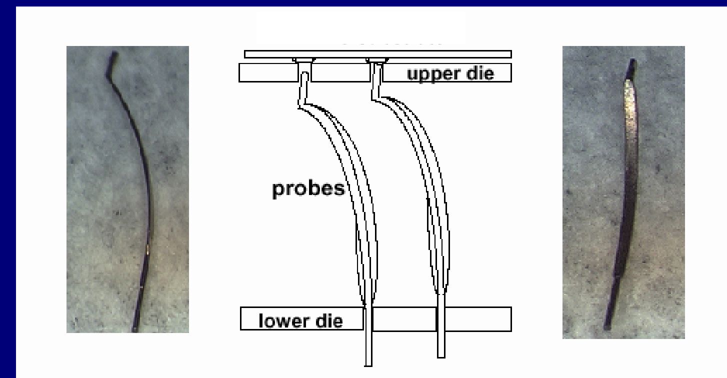
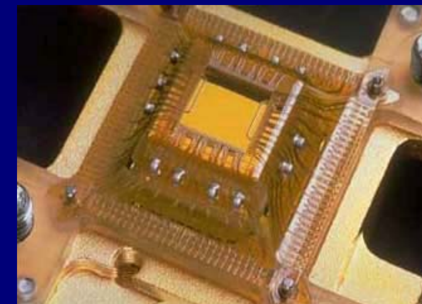


Illustration Courtesy of SWTW/Intel (ref. 3)

Experiences: Probe Technologies

- Membrane…..MEMS
  - Photo-lithographically Defined; Metallurgy on Polyimide Film or Silicon
  - Sourced From
    - Cascade Microtech (Pyramid Probe™)
    - IBM (TFI™)
    - SCS Hightech (MEMS VPC)



Courtesy of Cascade Microtech

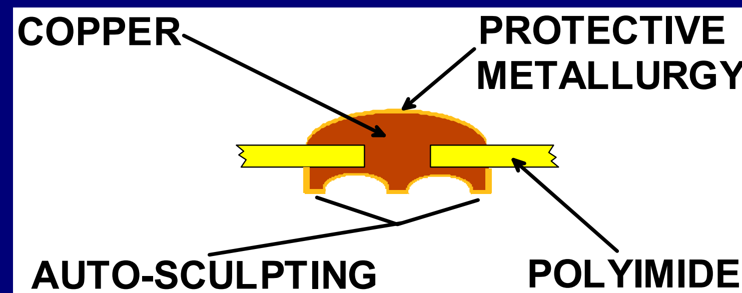
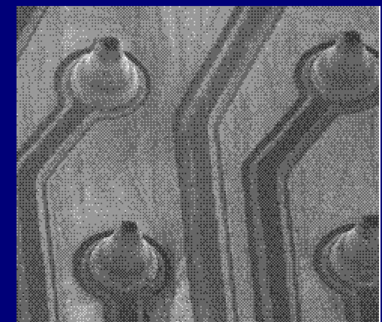


Illustration Courtesy of SWTW/IBM (ref. 2)



Courtesy of SCS Hightech

Experiences: Probe Technologies

- Hybrid Cantilever
  - Cantilever w. Wire Through Guide Plates
  - Sourced From
    - K&S (VertaProbe™)

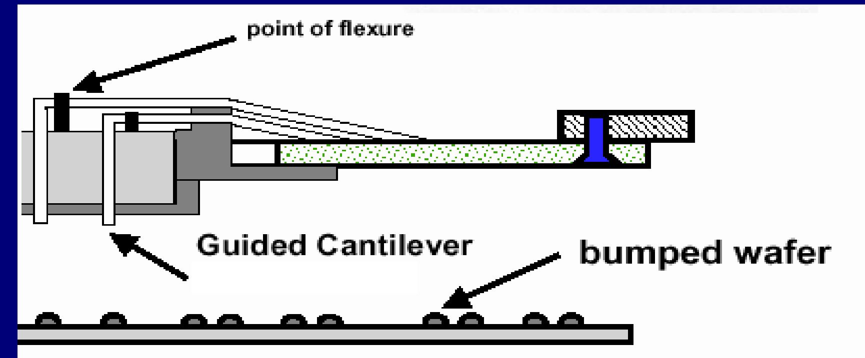


Illustration Courtesy of Motorola

Experiences: Probe Technologies

- Spring
  - Spring Probe Through Guide Plates
    - Sourced From
      - JEM (VSC – Vertical Spring Contact)

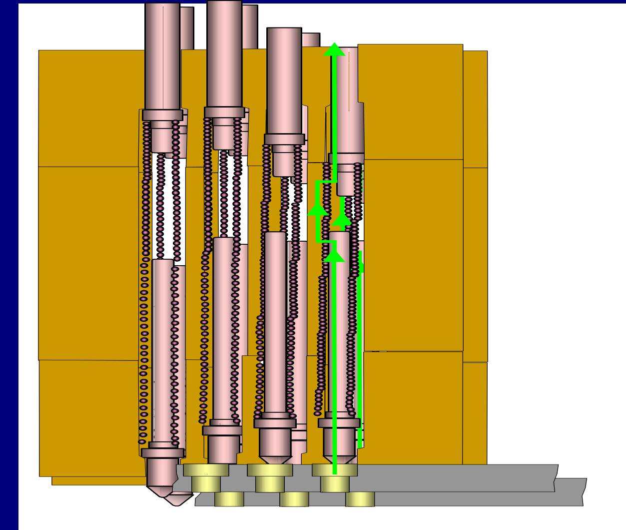
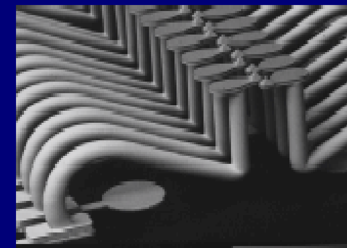
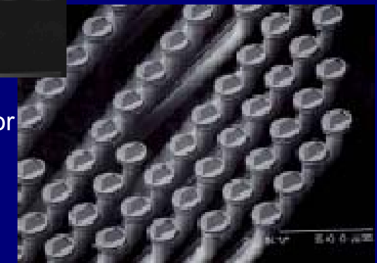


Illustration Courtesy of JEM



Courtesy of Formfactor

  - Wire Bonded to a Substrate & Formed; Tip Geometry
    - Sourced From
      - Formfactor (MicroSpring™)

Experiences: Applications

- Buckling Beam

Products	I/O's	
	Metallurgy Pitch (µm)	Config. #
Discrete IC's, power, ASICs, µprocessors, µcontrollers, RF, Mixed Signal, Chip Sets, Test Chip	PbSn Bump 160 - 500	Area Array 5 - ~5K
µcontrollers, DRAM, Smart Cards, Flash (emb), Test Chip	Al Pad 80 - 250	Peripheral / Inline 32 - ~5K

Experiences: Applications

- Membrane…..MEMS

Products	I/O's	
	Metallurgy Pitch (μm)	Config. #
ASICs, μprocessors, RF	PbSn Bump 200 – 225	Area Array ~25 - ~3K
Mixed Signal, RF	Al Pad 80	Peripheral / Inline 40 - >300

Experiences: Applications

- Hybrid Cantilever

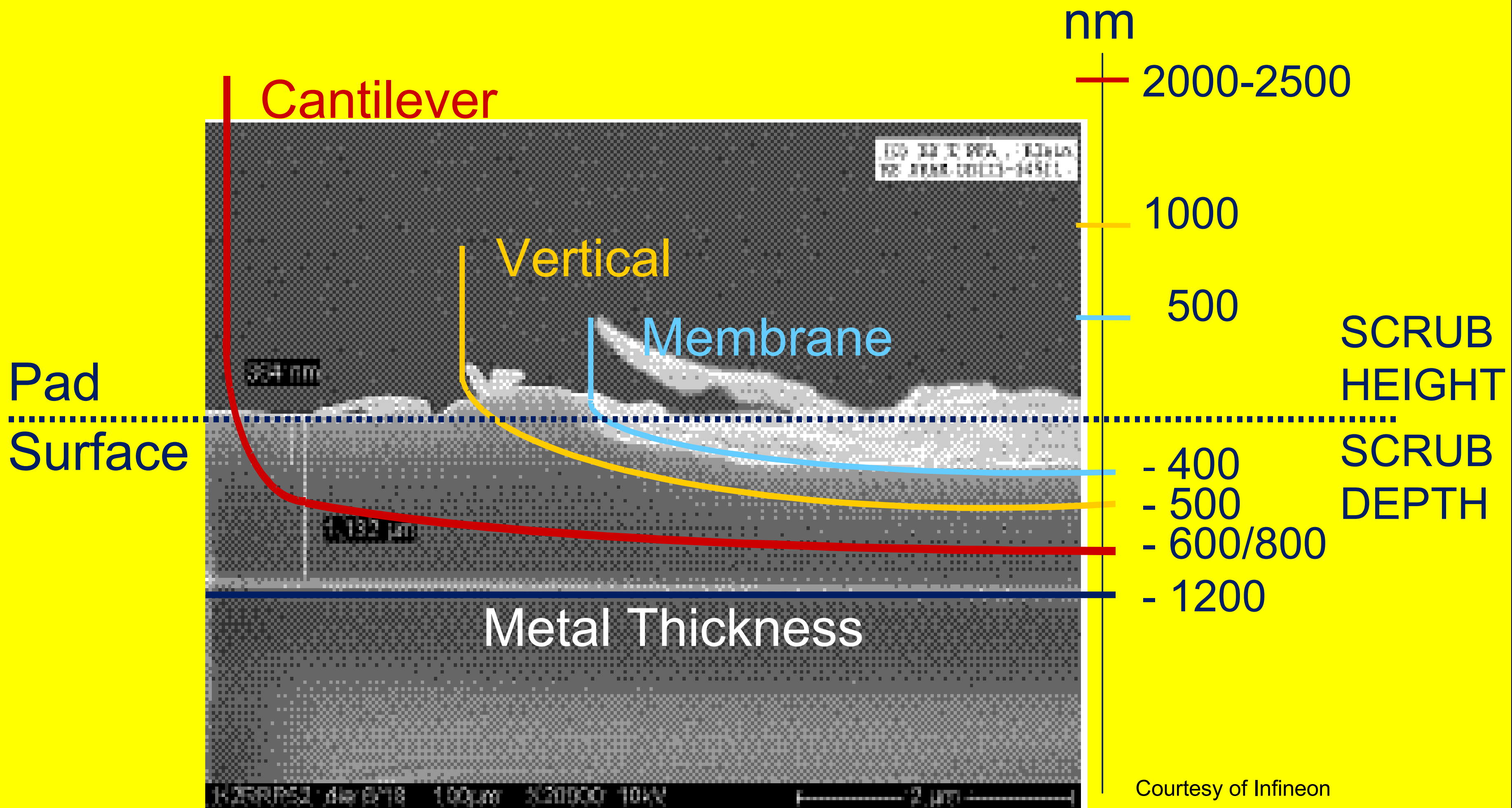
Products	I/O's	
	Metallurgy Pitch (μm)	Config. #
ASICs, μcontrollers	PbSn Bump 200 - 250	Area Array 400 - 800
Logic Chip Sets	Al Pad 35/50	Staggered 100 - 300

Experiences: Applications

- Spring

Products	I/O's	
	Metallurgy Pitch (µm)	Config. #
ASICs, µprocessors, Chip Sets	PbSn Bump 180 - 225	Area Array 800 - 3100
Flash	Al Pad 100	Inline 20x – 100x

Experiences: Pad damage v. Technology



Experiences: Maintenance

- Buckling Beam

Metallurgy	Cleaning		Repair	Lifetime
	Frequency	Method		
PbSn	50 - 2000	Brush, Abrasive Pad, Gel Pad	Some In-house	100K – 1M
Al Pad	200 - 1000	Brush, Abrasive Pad, Gel Pad	Some In-house	---

Experiences: Maintenance

- Membrane…..MEMS

Metallurgy	Cleaning		Repair	Lifetime
	Frequency	Method		
PbSn	150 – 500	Brush, Abrasive Pad	Mostly External	500K - >1M
Al Pad	---	Abrasive Pad, Chemical	None In-house	---

Experiences: Maintenance

- Hybrid Cantilever

Metallurgy	Cleaning		Repair	Lifetime
	Frequency	Method		
PbSn	50 – 150	Abrasive Pad	Non-repairable	100K – 1M
Al Pad	200	Abrasive Pad	Non-repairable	1M

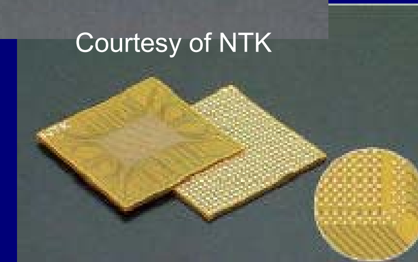
Experiences: Maintenance

- Spring

Metallurgy	Cleaning		Repair	Lifetime
	Frequency	Method		
PbSn	100	Abrasive Pad, Gel Pad	None In-house	>500K
Al Pad	---	---	None In-house	>500K

Experiences: Spacetransformers

- Wired
  - Buckling Beam
  - Provided by Probe Card Supplier
- Multi-Layer Ceramic
  - Buckling Beam, Membrane, Spring
  - Most are Provided to Probe Card Supplier; Some 3rd Party Sourcing
- Multi-Layer Organic
  - Buckling Beam
  - Most are Provided to Probe Card Supplier
- None
  - Hybrid Cantilever, Some Membrane



Courtesy of NTK

More Spacetransformer Info: "C4 Probe Card Space Transformer Technology Overview"; By Grace Chan & Justin Leung of Intel Corporation; 2000 SWTW

Experiences: Selection

- Buckling Beam

Sourcing			
Decision	2nd	Strengths	Weaknesses
Price, Performance, Support	Some	Mature, Repairable, Robust, Multi-DUT, Tip Shape	Pitch & Frequency Limitations

Experiences: Selection

- Membrane…..MEMS

Sourcing			
Decision	2nd	Strengths	Weaknesses
Performance	None	High Frequency, Planarity, Alignment, Fine Pitch	Cost, Leadtime, Single-Sourcing

Experiences: Selection

- Hybrid Cantilever

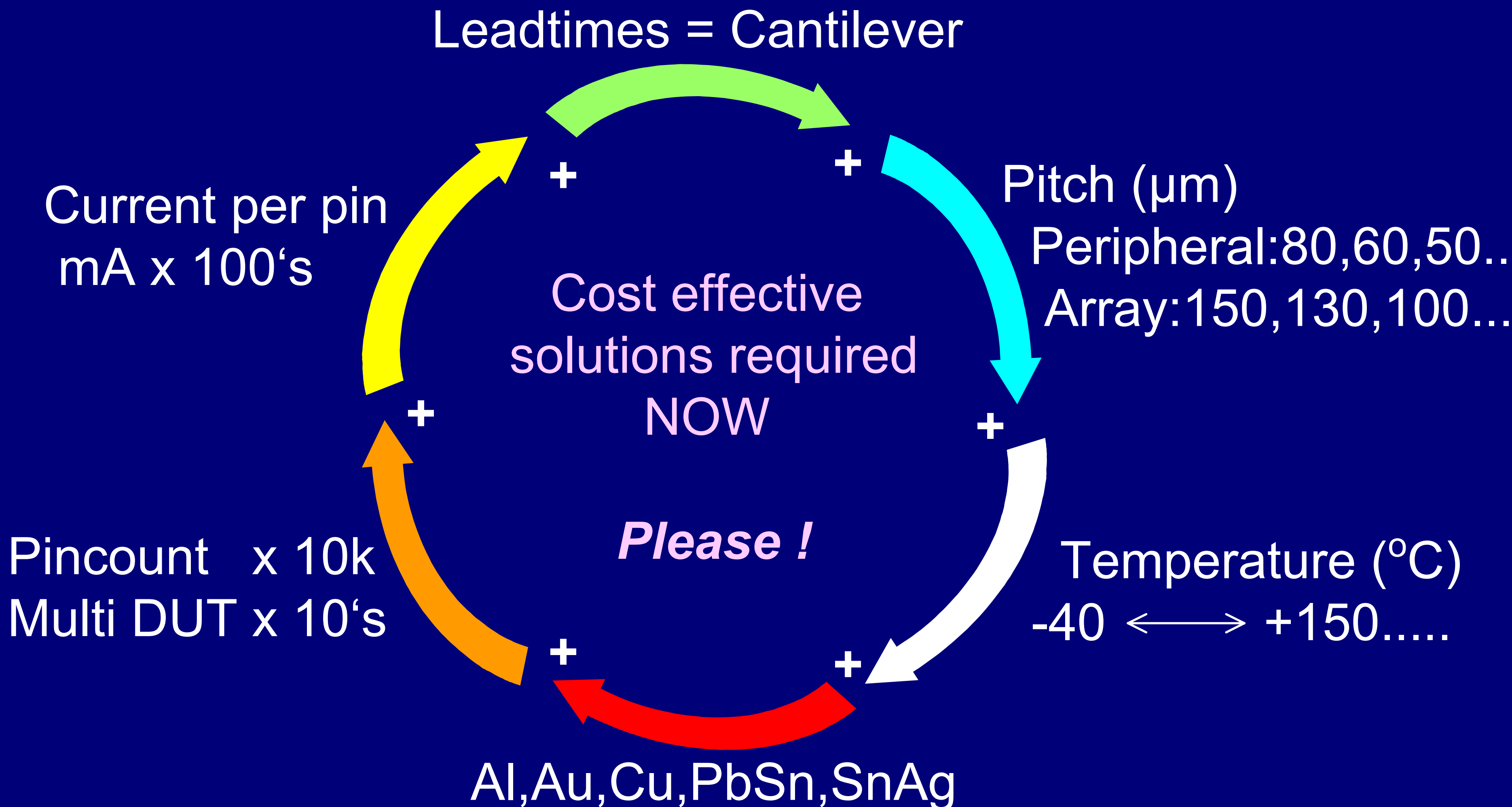
Sourcing			
Decision	2nd	Strengths	Weaknesses
Leadtime, Cost	None	Leadtime, Cost, Prototyping	High Frequency, Non-repairable, Single-Sourcing

Experiences: Selection

- Spring

Sourcing			
Decision	2nd	Strengths	Weaknesses
Performance	None	Performance, Quality, Mature	Cost, Leadtime, Single-Sourcing

Key Challenges



Wrap-Up

- Buckling Beam is Predominant Technology
  - Mature, Robust, Multiple Sources
- Vertical Probes
  - Accelerating Usage Across Application Spectrum
  - Proliferation of Suppliers / Technologies
  - Growing Multi-DUT Use
- Technical & Business Challenges to Meet Future Needs

Acknowledgements

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- Thanks to the Member company principals. Their spirit of cooperation has been essential to the success of the Wafer Probe Council

References

- Ref. 1:
  - "Area Array Interconnection Handbook"; edited by Karl Puttlitz & Paul Totta; Chapter 3 – Wafer-Level Test; Section 3.5.10.2; P.146. ©2001
- Ref. 2:
  - "A High Performance C4 Probe: TFI™"; by G. Das & F. Taber of IBM Microelectronics; Presented at 2001 SWTW; P. 8
- Ref. 3:
  - "Overview of C4 Array Probing"; by Justin Leung of Intel Corporation; Presented at 1999 SWTW; P.4

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